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I, JULIE BILLINGSLEY, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. 2002950518 for a patent by ROSS NADDEI as filed on 01 August 2002.

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J. Billingsley

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PROVISIONAL SPECIFICATION

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Invention Title:	A Battery Conditioning Apparatus

This invention is described in the following statement:

Field of the Invention

This invention generally relates to a battery conditioning apparatus. In particular, the invention relates to a battery conditioning apparatus that is operable to substantially prevent or reverse the accumulation of lead sulphate on the electrodes of a lead-acid battery.

Although the invention will be described with reference to 12 V and 24 V wet cell lead-acid batteries, it will be appreciated that this is by way of example only and that the invention may be used with other types of lead-acid batteries.

Brief Description of the Prior Art

Lead-acid batteries such as those commonly used in motor vehicles usually include a plurality of electrically interconnected cells. Each cell includes two plates that are referred to as electrodes. Typically, one of the electrodes is constructed from lead peroxide while the other electrode is constructed from spongy lead. The electrodes are immersed in an electrolyte which, in the case of wet cell lead-acid batteries, is usually provided by dilute sulphuric acid.

When the cells of the battery are functioning normally, the acid reacts with the electrodes, converting chemical energy into electrical energy so that a positive charge is built-up on the lead peroxide electrode and a negative charge on the other electrode. The charges on the different electrodes result in a potential difference or voltage being produced between the electrodes. The cells are usually constructed so that they each produce a

particular voltage and are interconnected so as to produce a desired voltage (e.g. 12 V or 24 V) at the terminals of the battery.

As the chemical reaction between the electrodes and the acid continues, lead sulphate forms on the surface of the electrodes, and the sulphuric acid is converted to water. When the surfaces of both electrodes are completely coated with lead sulphate, the battery is flat. Recharging the cell with an electric current restores the electrodes to their original condition and regenerates the sulphuric acid.

Battery conditioning apparatus have been developed which are able to prevent or reverse the accumulation of lead sulphate on the electrodes of a lead-acid battery. These apparatus produce electrical pulses that are applied to the terminals of the battery when the terminal voltage of the battery increases above a threshold value. When applied to the battery terminals, the electrical pulses prevent or reverse the accumulation of lead sulphate on the battery electrodes. It has been found that such battery conditioning apparatus can significantly increase the operating life and efficiency of batteries.

It has been found that battery conditioning apparatus of the aforementioned type are somewhat inefficient in regards to the proportion of generated electrical pulse energy that they are able output to a battery. Further, they do not allow for easy adjustment of the threshold voltage. Moreover, they do not provide any sort of indication as to the amplitude of the electrical pulses applied to the battery.

It is an object of the present invention to overcome, or at least

substantially ameliorate, one or more of the deficiencies of the prior art.

Other objects and advantages of the present invention will become apparent from the following description, taken in connection with the accompanying drawing, wherein, by way of illustration and example, an embodiment of the present invention is disclosed.

Summary of the Invention

According to a first aspect of the present invention there is provided a battery conditioning apparatus for preventing or reversing the accumulation of lead sulphate on an electrode of a lead-acid battery, the apparatus including an electrical pulse generator adapted to be coupled to the battery, the pulse generator including a switch, an inductor coupled to the switch, and a capacitor coupled to the inductor, wherein, in use, the switch is operated such that the inductor generates electrical pulses, and the inductor is directly coupled to the battery such that the electrical pulses are applied to the electrode.

According to a second aspect of the present invention there is provided a battery conditioning apparatus for preventing or reversing the accumulation of lead sulphate on an electrode of a lead-acid battery, the apparatus including an electrical pulse generator adapted to be coupled to the battery, and a controller operable to enable and disable the pulse generator when the battery voltage is respectively below and above a threshold voltage, wherein the threshold voltage is selectively adjustable by a user.

According to a third aspect of the present invention there is provided a battery conditioning apparatus for preventing or reversing the accumulation of lead sulphate on an electrode of a lead-acid battery, the apparatus including an electrical pulse generator adapted to be coupled to the battery, and a pulse amplitude indicator operable to indicate the amplitude of the pulses.

Brief Description of the Drawings

In order that the invention may be more fully understood and put into practice, a preferred embodiment thereof will now be described with reference to the accompanying drawing, in which Fig. 1 is a schematic circuit diagram of a battery conditioning apparatus according to a preferred embodiment of the present invention.

Detailed Description of the Preferred Embodiment

Referring to Fig. 1, a battery conditioning apparatus 10 for reversing sulphation on the electrodes of a 12 V lead-acid battery (not shown) includes a pulse generator 11, a controller 12 and a pulse amplitude indicator 13. The apparatus 10 is operable to prevent or reverse the accumulation of lead sulphate on the electrodes of a lead-acid battery by applying a series of electrical pulses across the terminals of the battery. The amplitude of the pulses applied across the battery terminals by the apparatus 10 is proportional to the amount of sulphate on the electrodes of the battery.

The apparatus 10 is coupled across the +ve and –ve terminals

of the battery such that the +ve battery terminal is coupled to the apparatus 10 via a 0.4 A/60 V poly-switch F1 that serves as a fuse. Power for the apparatus 10 is derived from the battery such that the supply voltage Vcc is held to a constant 10 V by a 10V zener diode D5. The zener diode D5 is coupled to a power supply filter including a 220 μF capacitor C2, 470 μH inductor L3, 560 Ω resistor R7 and 0.1 μF capacitor C3. The power supply filter is coupled to the poly-switch F1 via parallel connected 3 A toroid inductors L1 (100 μH) and L2 (4-10 μH). Inductors L1 and L2 are directly coupled to the +ve battery terminal via the poly-switch F1.

The pulse generator 11 is operable to generate the electrical pulses that are applied across the +ve and –ve terminals of the battery by the apparatus 10. The pulse generator 11 includes a square wave generator that is provided by a Schmitt trigger NAND logic gate IC2a and additional circuitry associated therewith. The additional circuitry includes a 2.2 nF capacitor C1 that is coupled to the inputs of NAND gate IC2a. Further, a 1 MΩ potentiometer P2 and a 560 kΩ resistor R2 are connected in series between the inputs and output of the NAND gate IC2a. A 2 kΩ potentiometer P1, 470 Ω resistor R1 and a IN4148 diode D1 are also connected in series between the inputs and output of the NAND gate IC2a such that they are connected in parallel with respect to potentiometer P2 and resistor R2. The square wave generator generates a 1 kHz square wave having a duty cycle of approximately 99.8% due to the different charging and discharging paths of the capacitor C1. The aforementioned frequency and duty cycle values mean

that the generated square wave is high for approximately 2 μs and low for approximately 0.998 ms of each cycle.

The square wave signal produced by the wave generator is input into both inputs of a second NAND gate IC2b so that NAND gate IC2b functions as an inverter. The inverted square wave signal produced by NAND gate IC2b is then input into one of the inputs of a third NAND gate IC2c. The other input of NAND gate IC2c is coupled to the output of the controller 12 which is operable to enable and disable the pulse generator. The output of NAND gate IC2c is coupled to both inputs of a fourth NAND gate IC2d so that NAND gate IC2d functions as an inverter. Thus, assuming that the pulse generator 11 is enabled by the controller 12, the signal produced at the output of NAND gate IC2d will be an inverted version of the square wave generated by the square wave generator. The square wave signal at the output of NAND gate IC2d will therefore have a frequency of 1kHz and a duty cycle of approximately 0.2% which means that the square wave will be high for approximately 0.998 ms and low for approximately 2 μs of each cycle. The output of NAND gate IC2d is coupled to the gate of a MOSFET transistor Q1 that functions as a switch. Transistor Q1 may, for example, be an IRF 540 or IRF 530 transistor. The drain of transistor Q1 is coupled to the previously described power supply filter by parallel connected inductors L1 and L2. In addition, the drain of transistor Q1 is coupled to the +ve battery terminal via poly-switch F1. The source of transistor Q1 is coupled to the –ve battery terminal.

If the pulse generator 11 is enabled so that the inverted version

of the square wave generated by the square wave generator appears at the output of NAND gate IC2d, the transistor Q1 will be switched ON and OFF in an alternating manner as the voltage at the gate of the transistor Q1 varies between the high and low states. When transistor Q1 is switched ON, an effective short circuit is created between the drain and source of the transistor Q1 so that current is able to flow between the +ve and –ve battery terminals through the poly-switch F1, inductors L1, L2 and transistor Q1. The maximum current that flows between the +ve and –ve battery terminals when the transistor Q1 is switched ON is mainly dependent upon the impedance of the poly-switch F1. When transistor Q1 is switched OFF, an effective open circuit is created between the drain and source of the transistor Q1 so that current is unable to flow between the +ve and –ve battery terminals through the transistor Q1. The creation of this open circuit results in the magnetic energy stored in the inductors L1 and L2 being converted into a relatively high voltage electrical pulse which is output to the +ve battery terminal. The duration of each pulse is approximately 100 to 200 ns and the energy of each pulse can be estimated as the total inductance provided by inductors L1 and L2 multiplied by the rate of change of current therethrough. The amplitude of the electrical pulse is dependent upon the amount of sulphate on the battery electrodes. If only a small amount of sulphate is present on the electrodes the amplitude of the pulse will be relatively low. If a large amount of sulphate is present on the electrodes the amplitude of the pulse may be as high as 64V. The average current consumption of the apparatus 10 is approximately 20 mA when the pulse generator 11 is enabled.

As previously mentioned, the controller 12 is operable to enable and disable the pulse generator 11. The controller 12 includes a comparator IC1a that compares the forward bias voltage of a 1N4148 diode D3 with a divided version of the battery voltage. A 6.8 kΩ resistor R6 and a parallel connected 0.1 μF capacitor C4 are connected between the supply voltage Vcc and the output of comparator IC1a. The output of comparator IC1a is connected to the second input of NAND gate IC2c of the pulse generator 11. The –ve input of comparator IC1a is connected to the anode of diode D3 while the cathode of diode D3 is connected to the –ve terminal of the battery. A 1 μF capacitor C7 is connected in parallel to diode D3 and a 39 kΩ resistor R12 is connected to the anode of D3 and the supply voltage Vcc. A parallel connected 0.1 μF capacitor C3 and a 5.6 kΩ resistor R5 are coupled to the +ve input of comparator IC1a and the –ve battery terminal. A 100 kΩ resistor R3 and parallel connected resistors R4 (130 kΩ) and R13 (6.8 MΩ) are also coupled to the +ve terminal of the comparator IC1a. Resistors R3, R4 and R13 are coupled to the poly-switch F1 by a switch S1.

Resistors R3, R4, R13, R5 and switch S1 form a voltage divider network that is operable to divide the battery voltage in either one of two ways depending upon the position of the user operable switch S1. The position of switch S1 depends upon whether a user wishes the controller 12 to enable the pulse generator 11 when the battery voltage exceeds a threshold voltage of 10 V or 12.8 V. If the battery voltage is lower than the selected threshold voltage, the output of comparator IC1a is low which disables NAND gate IC2c and, hence, the pulse generator 11 since the square wave produced by the

square wave generator is not passed to the transistor Q1. The current consumption of the apparatus 10 decreases to approximately 2 mA when the pulse generator 11 is disabled. If the battery voltage increases above the selected threshold voltage, the output of comparator IC1a goes high which enables NAND gate IC2c and, hence, the pulse generator 11 since the square wave produced by the square wave generator is passed to transistor Q1.

The pulse amplitude indicator 13 is operable to indicate the amplitude of the pulses that are input into the battery by the pulse generator 11. The pulse amplitude indicator 13 includes three comparators IC1b-d and other associated circuitry. The associated circuitry includes three light emitting diodes LED2-4 which are coupled to the outputs of the comparators IC1b-d. In particular, LED2, which is green, is coupled to the output of comparator IC1b via a 1N4148 diode D2. LED3 is yellow and is coupled to the output of comparator IC1c, while LED4, which is red, is coupled to the output of comparator IC1d. The anodes of LED2-4 are coupled to the +ve battery terminal via a 2.2kΩ resistor R8. The +ve input of each comparator IC1b-d is coupled to the anode of diode D3. The –ve input of comparator IC1b is coupled to the +ve input of comparator IC1a of the controller 12. The –ve input of comparator IC1c is coupled to the +ve battery terminal via a 820 kΩ resistor R9 and a 1N4148 diode D4. The –ve input of comparator IC1c is also coupled to the –ve battery terminal via resistor R9 and a 0.1 μF capacitor C6. A 10 kΩ resistor R10 interconnects the –ve inputs of comparators IC1c and IC1d. The –ve input of comparator IC1d is also coupled to the –ve

battery terminal via a 20 kΩ resistor R11.

The operation of the pulse amplitude indicator 13 is such that LED2 is illuminated while the apparatus 10 is operating and the amplitude of the pulse produced by the apparatus 10 is less than approximately 20 V. LED3 illuminates if the pulse produced by the apparatus 10 is above 20 V. Since LED3 has a lower voltage drop compared to LED2 owing to diode D2 being connected in series with LED2, LED3 and LED2 cannot be illuminated simultaneously. LED4 illuminates if the pulse produced by the apparatus 10 is higher than 30 V. LED3 and LED4 cannot be illuminated simultaneously since LED4 has a lower voltage drop compared to LED3.

The apparatus 10 is also suitable for use with 24 V batteries. When used with a 24 V battery the threshold voltages of the controller are 21 V and 25.6 V, respectively.

The foregoing describes only one embodiment of the present invention and modifications, obvious to those skilled in the art, can be made thereto without departing from the scope of the present invention. For example, the apparatus 10 can be readily modified for use with batteries other than 12 V or 24 V batteries. If the apparatus 10 was to be modified for use with 4 V or 6 V batteries, additional circuitry would be required to convert these low voltages to the 12 – 18 V required by the zener diode D5 to produce the 10 V supply voltage Vcc.

DATED this 1st day of August 2002

Ross Naddei

By his Patent Attorney

CULLEN & CO.

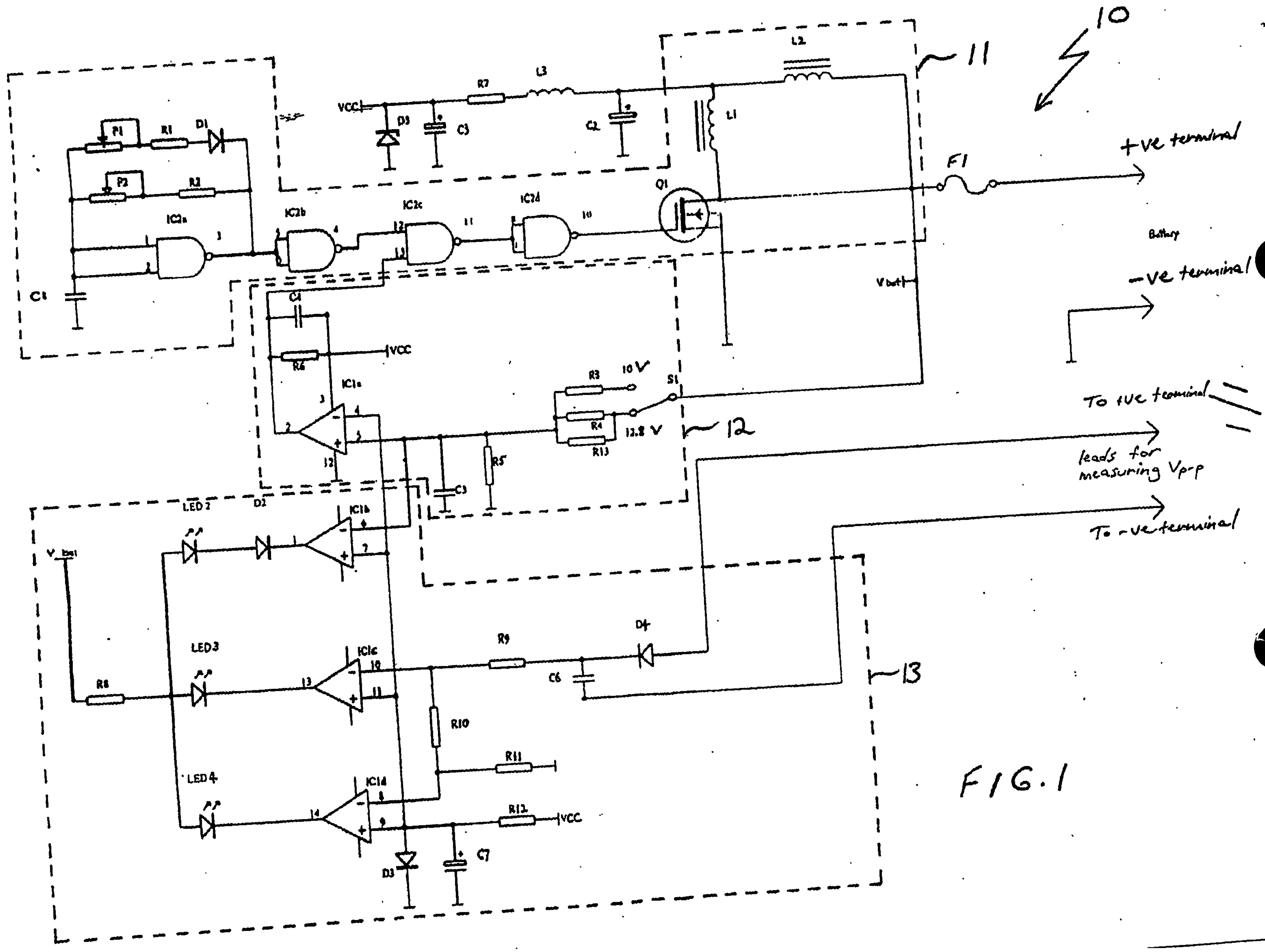
10
11
12
13
L2
L1
L3
R7
VCC
D3
C3
C2
P1
R1
D1
P2
R2
IC2a
IC2b
IC2c
IC2d
Q1
F1
+ve terminal
Battery
-ve terminal
Vbat
C1
C4
R6
VCC
IC1a
R3
10 V
S1
R4
12.8 V
R13
R5
To +ve terminal
leads for measuring Vp-p
To -ve terminal
LED 2
D2
IC1b
V_bat
LED3
IC1c
R9
D4
C6
R8
R10
R11
LED4
IC1d
R12
VCC
D3
C7

FIG. 1